ZOOPLANKTON OF LAKE SÜNNET (BOLU) AND DETERMINATION OF SOME ENVIRONMENTAL VARIABLES

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ZOOPLANKTON OF LAKE SÜNNET (BOLU) AND DETERMINATION OF SOME ENVIRONMENTAL VARIABLES

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ABSTRACT

ZOOPLANKTON OF LAKE SÜNNET (BOLU) AND DETERMINATION OF SOME ENVIRONMENTAL VARIABLES

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Zooplankton fauna and environmental quality of Lake Sünnet were monitored using bioiogical and physicochemical variables obtained from different six stations between May 2005 and December 2006. Water samples were collected from four different littoral parts (L-1, L-2, L-3, L-4) and two vertical parts (V-Y, V-4) of lake as a monthly. Physical variables such as pH, DO, % saturation, salinity, electrical conductivity, water temperature were measured each sampling period in a field study area at the same time, chemical and microbiological analysis were made in the labarotory at the same day. In this study totally 23 rotifer species (*Anuraeopsis fissa, Ascomorpha ovalis*, *Asplanchna periodonta, Brachionus angularis, Cephalodella catellina, C. gibba, Colurella adriatica, Euclanis dilatata, Filinia longiseta, F. terminalis, Keratella cochlearis, K. quadrata, Lecane (M.) Closterocerco, L. lunaris, L. luna, Notholca acuminate, N. squamula, Polyarthra dolichoptera, P. major, P.remata, Pompholyx complanata, Trichocerca (D.) similis, T. weberi)* three cladocerus species (*Daphnia longispina, Bosmina longirostris, Chydorus sphaericus*) and 2 copepoda genus (*Thermocyclops*, *Cyclops)* were identified in Lake Sünnet. Rotifer species were dominant among zooplankton. Seasonal distribution of zooplankton species with selected environmental variables were evaluated by using canonical correspondence analysis (CCA). According to CCA result, variables explain % 41 of total variation and model is significant (p <0.005).

Key Words: Zooplankton, Lake Sünnet, seasonal distribution, environmental variables, Seasonal Changes.

ÖZET

SÜNNET GÖLÜ ZOOPLANKTONU VE BAZI ÇEVRESEL DEĞİŞKENLERİN BELİRLENMESİ

Deveci, Aziz
Yüksek Lisans, Biyoloji Bölümü
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Sünnet Gölü zooplankton faunası ve çevre kalitesi, 6 farklı istasyondan elde edilen biyolojik ve fizikokimyasal değişkenler kullanılarak Mayıs 2005 ve Aralık 2006 arasında incelenmiştir. Gölün 4 farklı litoralinden (L-1, L-2, L-3, L-4) ve 2 farklı derin kısımlarından (V-Y, V-4) aylık olarak su örnekleri toplanmıştır. pH, çözünmüş oksijen, yüzde çözünürlük, tuzluluk, elektriksel iletkenlik ve sıcaklık gibi fiziksel değişkenler, arazide örnekleme yapılırken ölçülmüştür. Kimyasal ve mikrobiyolojik analizler aynı gün içinde laboratuvarda yapılmıştır. Bu çalışmada, Sünnet Gölünde 23 rotifer (*Anuraeopsis fissa, Ascomorpha ovalis*, *Asplanchna periodonta, Brachionus angularis, Cephalodella catellina, C. gibba, Colurella adriatica, Euclanis dilatata, Filinia longiseta, F. terminalis, Keratella cochlearis, K. quadrata, Lecane (M.) Closterocerco, L. lunaris, L. luna, Notholca acuminate, N. squamula, Polyarthra dolichoptera, P. major, P.remata, Pompholyx complanata, Trichocerca (D.) similis, T. weberi*) 3 kladoser (*Daphnia longispina, Bosmina longirostris, Chydorus sphaericus*) türü ve 2 kopepod *(Thermocyclops*, *Cyclops*) cinsi tanımlanmıştır. Zooplankton türleri arasında rotiferler baskındı. Seçilmiş çevresel değişkenler ile zooplankton türlerinin dağılımı CCA kullanılarak değerlendirilmiştir. CCA

sonuçlarına göre, toplam değişkenin % 41’ i açıklanmıştır ve model anlamlıdır ($P<0.005$).

Anahtar Kelimeler: Zooplankton, Sünnet Gölü, mevsimsel dağılım, çevresel değişkenler, mevsimsel değişim.

To My Father and My Mother

GAZİ and TAMAM

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1 Introduction

The name of plankton is descended from the Greek word "planktons", meaning "wanderer" or "drifter". This term had been used first time by Victor Hensen (1886) and Haeckel (1890) has renamed as used real meaning (Özel 1998). Though some forms of plankton are able to move vertically several hundred meter, their horizontal movement is primarily limited by currents in the body of water they inhabit (Özel 1998). Planktonic organisms are classified according to its size as Megaplankton (n cm), macroplankton (1 mm -1 cm), Mesoplankton (0.5 – 1.0 mm), Microplankton (0,06 – 0,5 mm) Nanoplankton (0.005 – 0,06 mm) and Ultraplankton (0,0005 – 0,0050 mm). Plankton is consist of two groups based on its' origin. These are phytoplankton and zooplankton. The main groups of zooplankton consist of Copepoda and Cladocera which belong to the subphylum Crustacea and phylum Rotifera. Besides, zooplankton also includes protozoa, some crustaceans, small fish's and insect's larvae (Wetzel 2001). Zooplankton plays an important role as an intermediate component between primary producer and planktivorous fishes (Saravanakumar et al. 2007). Zooplanktonic organisms that occupy the second tropic level of the aquatic food web are important as prey for invertebrates and fishes and it is also good predator for some algae, bacteria and small microinvertabrates (Akbulut, 2004). Zooplankton is affected quantitatively and qualitatively by some environmental factors such as temperature, dissolved oxygen, salinity, other physicochemical parameters and biotic interactions (Pennak, 1946). Therefore, most of the zooplankton is also important to indicate the water quality of marine and freshwater ecosystem as indicator organisms, such as crustaceans and rotifers.

(Gannon and Stemberger, 1978; Bekleyen, 2003). Sladecek (1983) reported that rotifer species are used as indicator of saprobic index and trophic level of lakes.

A number of studies of the zooplankton fauna have previously been studied in Turkey. Gündüz (1984) identified 49 species belong to copepoda, cladocera and rotifera in Lake Karamık and Hoyran. Seventy-eight rotifer species were reported from 19 different localities in Turkey by Dumont (1987). Gündüz (1990) reported a new crustacean species from Bafra in Balikgöl. Then, Segers et al. (1992) defined 91 Rotifera species from 21 different freshwater sites and 42 of these species are new to the Turkish fauna. Akbulut (1998) studied about biomass analysis related to zooplanktonic organisms living in Lake Mogan. Altındağ and Özkurt (1998) investigated to zooplankton fauna of Dam Lakes Kunduzlar and Çatören. Altındağ and Yiğit (1999) identified 32 rotifera species and 2 genus in Lake Akşehir. Güher (1999) has conducted taxonomic studies about Cladocera and copepoda in Lake Mert Erikli, Hamam and Pedina. Other study includes Akbulut (2000) in Lake Akşehir investigated community structure of zooplanktonic organisms.

Altındağ (1999, 2000) reported 53 rotifera species, which 7 of them are new for Turkish rotifera fauna in Lake Abant and Yedigöller. Ustaoğlu et al. (2001) identified 12 cladoceran and 4 copepoda species in İkizgöl. In following study, Bekleyen (2001) taxonomically investigated Rotifera fauna of Devegeçidi Dam Lake. Then, Yiğit (2002) conducted Seasonal fluctuation in the Rotifer fauna of Kesikköprü Dam Lake. In other study, Güher (2003) researched community structure of Zooplanktonic organisms in Lake Mert, Erikli, Hamam and Pedina. Saler (2004) identified 17 Rotifera species in Keban Dam Lake.

Akbulut (2004) investigated relationship between zooplankton and abiotic factors using CCA (canonical correspondence analysis). Emir (2004) invastigated Lake Çavuşcu, Eber, Akşehir Karamuk both taxonomy of rotifera species and their relations with environmantal variables in phD thesis. Ustaoğlu (2004) has compiled zooplankton of Turkish inland waters since 1940 and conducted 229 rotiferans, 92 cladocerans and 106 copepods taxa were listed. Yiğit and Altındağ (2005) reported 18 species belong to rotifera, 9 to cladocera and 4 to copepod in Hirfanlı Dam Lake. Besides, Mis et al. (2006) studied about zooplankton composition of west black sea region lakes including Lake sünnet. Lately, Yıldız et al. (2007) recorded 18 rotifera, 8 cladocera and 4 copepoda in Lake Marmara. Külköylüoğlu et al. (2007) reported Ostracoda species from Lake Sünnet. Recent studies in Lake Sünnet, Balci (2008) investigated to Ostracoda fauna and ecology of Lake Sünnet. Taşdemir et al. (2008) studied about Diptera and Ephemeroptera of Lake Sünnet.

The purpose of the study, to determine zooplankton species in Lake Sünnet and to observe seasonal changes of zooplankton species based on Physical and chemical variables.

1.1 Phylum Rotifera

1.1.1 General Characteristics of Rotifera

The phylum Rotifera are relatively small group of microscopic, ranging from about 50-2.000 μm, aquatic or semiaquatic invertebrates. Rotifers can be found in many freshwater, brackish and marine environments, even humid terrestrial habitats. In general, Rotifers include three main parts: head, body and feet (Figure 1).

Rotifera include three main features: a ciliated anterior end, called the corona; specialized pharynx called mastax with complex set of hard jaws, trophi; and a thickened body wall, called the lorica. In many species, the corona is consisting of two ciliated concentric rings that are called trochus and cingulum to provide metachronal beat (Wallace, 2002).

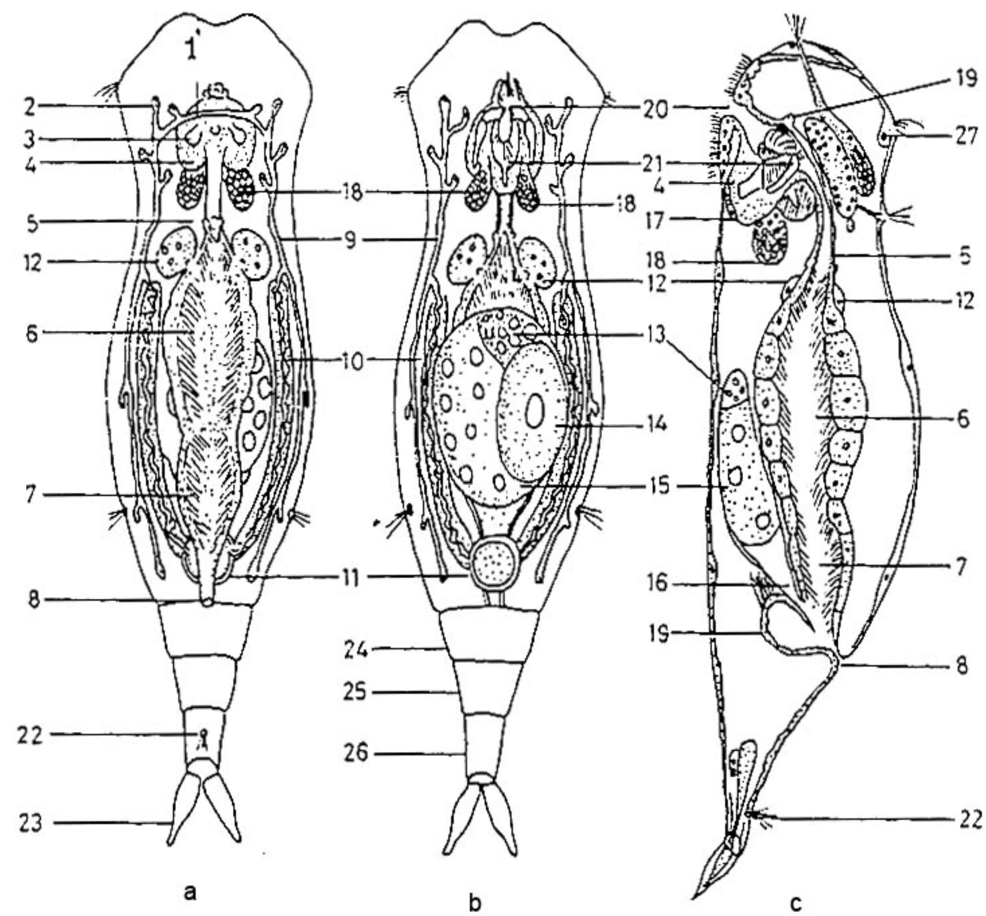

Figure 1 General appearance of Rotifera (Koste, 1978a).

1) Protonephridium cannal 2) Malpighi cells 3) Dorsal Salivary Gland 4) Mastax 5) Eusaphagous 6) Stomach 7) Intestine 8) Anus 9) capillary tubules 10) Protonephridium 11) Urinary track 12) Duct 13) Ovarium 14) Ovary 15) Vitallerium 16) Oviduct 17) Ganglion of Mastax 18) Ventral salivary Gland 19) Dorsal sense organs 20) Mouth 21) Trophi 22) Caudal sense organ 23) Toe
24-26) Foot segments 27) Epidermis

Other important feature of rotifera is a muscular pharynx with chitinous jaws that is called trophi (Koste 1978 a, b). Mechanic digestion is the most important function of the mastax. Food is taken by corona, progress through the mouth and reaches the ventral mastax. Trophi is classified by nine types based on size and shape of elements as Malleate, malleoramate, ramate, uncinate, virgate, forcipate, incudate, cardate and fulcrate (Wallace and Snell, 2006). Third important feature of rotifers is the body wall or integument of rotifers. The synctial integument of some rotifers species include layer of filamentous, keratin-like proteins. Such species that have thickened body wall are called loricate. Species lacking such thickening are called illoricate. Therefore, loricate and trophi are marker characteristics for identifying of many rotifers species (Wallace and Snell, 2006).

Nervous system of rotifers is simple, single large cerebral ganglion, generally called the brain, which is located on the mastax and dorsally below the corona. Paired, ventral neurons extend from the brain to whole body of rotifers that diverge along the way into various organs. Sensory organs of rotifers occur to dorsal, ventral antenna and receptors. Three types of sensory organs can be distinguished: mechanoreceptors, chemoreceptors, photoreceptors that are located on the corona and body surface.

Reproductive organs of many female rotifers species are compose of three components: ovary, vitellarium, and follicular layer. Male reproductive organs consist of testis and ciliated sperm duct. Most rotifers are oviparous, releasing their eggs by way into cloak outside the body where the embryos grow.

On the contrary, a few species of rotifers are ovoviviparous, carrying their eggs inside of the body until embryos develop. Three monophyletic groups, bdelloids, monogonants, and seisonids have evolved different reproductive modes: seisonids are obligetely sexual, monogonants exhibits facultative parthenogenesis producing haploid males, and bdelloids reproduce exclusively by ameiotic parthenogenesis (Gilbert 2004; Wallace 2002).

1.1.2 Ecology of Phylum Rotifera

Rotifers are important components in freshwater ecosystem. They respond more quickly to environmental changes and rotifers are more sensitive against changes in water quality such as, temperature, pH, salinity and some chemicals (nitrate, ammonium, calcium) (Gannon and Stemberger 1978, Orsi and Mecum 1986). Beside, not only rotifers affect these kinds of abiotic factors, but also some biotic factors are important for the rotifers distribution and density such as prey- predator interactions, competition for nutrients (Weglenska et al. 1997). Sharma (2000) noticed that some species of rotifer such species *Brachionus mirabilis, Euchlanis triquetra, Lepadella cristata, Lecane pertica, Testudinella tridentata* and *T. parva* were shown acidophilic characteristics. Gray (1953) noted that a variety of rotifer species generally observe at temperatures ranging from 9 to 20ºC.

The Rotifera fauna plays significant role in the food chain and biological productions of waters such as aqua pollution indicators, or and water quality monitor (Sladecek 1983).

Distribution of rotifers has very wide range all over the world because of their high reproductive ability and their eggs easily transported by wind, grazing animals and birds.

1.2 Class Cladocera

1.2.1 General Characteristics of Cladocera

The group of the Cladocera is a subdivision of the large aquatic arthropod class, the crustacea. Most of the Cladocera have about 0.2 -3 mm body length. Cladocerans consist of a head, a thorax and an abdomen (Figure 2). They have a two-valved carapace covering most of the body except the appendages. Carapace is a rigid, including cuticle layer, exoskeleton of Cladocera. They also include unpaired compound eye on the forehead. Beside, Cladocera has two pairs of antenna: The first pair of antennae that contains sensory organs is quite small and is attached to the rostrum. The second pair of antennae is the primary organ of locomotion and catching food in most Cladocera. Therefore each antenna possesses long setae, which is important to taxonomically identify cladocera. Also, head is composed of optic ganglion, ocellus and front part of digestive system. But, ocellus does not have all clacocera species such as *Diaphanosoma*, *Daphnia retrocurva*, *D. Longiremis*. On the lower side of the head is the mouth, surrounded by the upper lip in front, the mandibles at the sides, jaws is called maxillae at the back and labrum.

Thorax of Cladocera consist of 4 -6 segments. However, these segments can only observe through the thoracic legs. Fundamental function of thoracic legs carries oxygen and nutrients by filtering of water (Simirnov, 1992).

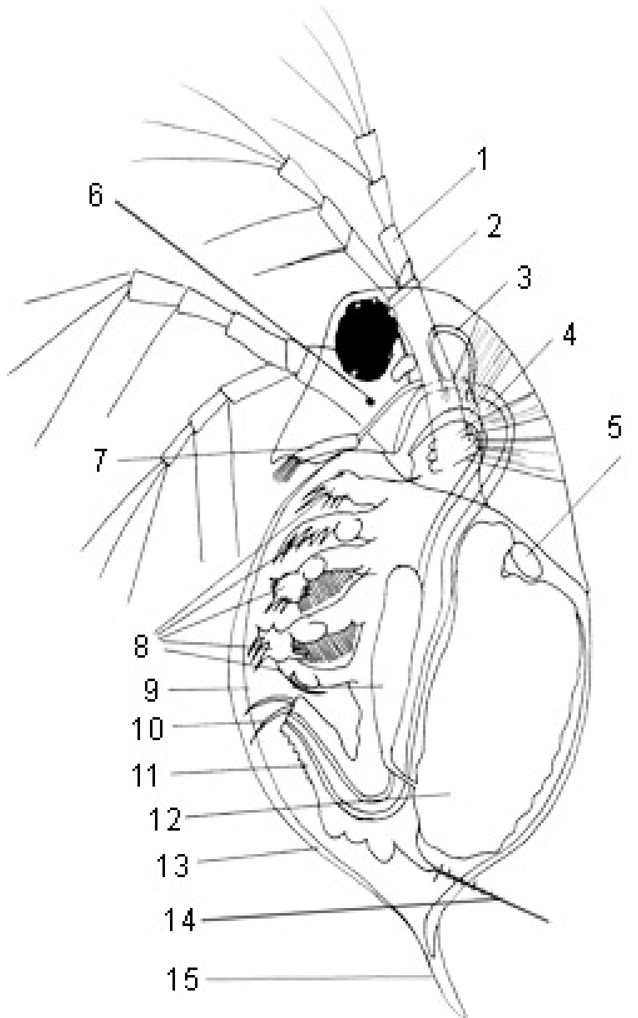

Figure 2 General Appearance of a Cladocera Species (http://www.cladocera.de/cladocera/cladocera.html).
1) Antenna 2) Compound eye 3) Enzyme Gland 4) Esophagus 5) Heart 6) Nauplius eye 7) Antennula 8) phyllopods 9) Ovar 10) Furca claws 11) Post abdomen 12) Brood 13) Carapax shell 14) Rudder bristle 15) Spina.

Abdomen that include anus, furca claws, spin is the last part of the body.

Male cladocers are morphologically smaller than female individuals. Cladocera exhibits parthenogenetic reproduction to the long period of the year like rotifers.

Metamorphosis does not observe during their developmental stage. Some species of cladocera reproduce sexually to accommodate environmental conditions.

1.2.2 Ecology of Cladocera

Cladocera mostly find in freshwater ecosystem. Although they are common in littoral parts where nutrient is abundant, cladocera can catch to vertical of freshwater. A few species such as *Alona quadrangularis* and *Drepanothrix* generally live near the bentic of freshwater. However, they do not completely adapt living these conditions (Metin, 2005). On the contrary, genus Ilyocryptus and Monospilus are common in bentic and their body is adapted to live clay layer. So, its' body shell is covered by algae (Metin, 2005).

Cladocerans are important group of zooplankton, which form the second trophic level of the food chain in aquatic environments. They feed generally phytoplankton and detritus. So, they are important aquatic link as secondary consumer.

Many cladocerans species are common acidic and eutrophic temperate lakes (Meijering, 1979). So some species of cladocera play significant role as an indicator of water quality and saprobitiy of lakes.

1.3 Class Copepoda

1.3.1 General Characteristics of Copepoda

Copepoda is a group of small crustaceans found in the marine environment and nearly all freshwater ecosystems. Mean adult length of copepoda is typically, without furcal setae, one millimeter to two millimeter. However, some marine free- living species and some parasitic forms may be 10 mm to 30 mm long. (Dussart and Defaye 2001) Three different types of copepods are defined: elongated, fusiform, or cylindrical. They basically consist of 16 somites. Copepoda is made up of 12 pairs of appandages: antennules, antennae, mandibles, maxillules, maxillae, maxillipeds, four natatory legs, the modified fifth legs and sixth legs. Their body consists of three segmented parts: head, thorax, and abdomen. Head and thorax are often fused to form a cephalothorax. Moreover, head includes two pair of segmented antenna, one of them is long and other one is short.

Copepoda body commonly possesses 11 segments. External skeleton or integument is composed of three different structures. Outside of integument include thin, multilayered epicuticle and a procuticle, epidermis, and the basal lamina.

Copepoda nervous system consist of a central nervous system that have brain or cerebrum, paired ganglia, proceeding ventrally in a ventral nerve cord, and a sympathetic system.

Copepoda typically exhibits sexual reproduction and sexes are separated as male and female. Male have one, sometimes two testes and one or two vasa deferentia. Female genital apparatus consist of a single ovary. Germinal part of the ovary is located posteriorly.

1.3.2 Ecology of Copepoda

Free-living freshwater copepods are found almost in all aquatic ecosystems such as littoral, deep, superficial, permanent, temporary waters, and humid terrestrial habitats, even frozen surface area of Antarctic lakes.

Biotic and abiotic factors of Lake Ecosystem are important to copepoda communities. Because, composition of their communities is affected biotic and abiotic factors: important abiotic factors are light, temperature, some variation in physical and chemical qualities of environment including pH, ions, organic compounds and pollutants. Moreover, biotic factors play key roles succession of planktonic copepods, including amount of nutrients prey predator relationships (Dussart and Defaye 2001). Even though copepods are food for many planktivorous fishes, they are also important predators of rotifers, Cladocera, Protozoa and insect larvae.

2 Materials and Methods

2.1 Study Site Description

Lake Sünnet (N 40° 25' 20", E 30° 57' 25", ca. 1050 m a.s.l.) (Figure 3), which is about 90 km west of Bolu (Turkey), is a naturally landslide dammed lake. It is located at about 1030 m high from sea level with a total surface area 18 hectare and about 1.5 million m^3 of volume (in this study). The maximum depth of lake is 13 m with approximately 800 m maximum length and 120 m maximum width.

Lake Sünnet is typically landslide dammed lake, which has been formed by breaking off limestone blocks and rubbers from deep, narrow, and V shaped Gökdere Valley (Abdüsselamoğlu 1959).

Nowadays, even though water of lake has been run out by using agricultural activities, some creeks, including Karaköy creeks from the south part, Kuru creek from the south-west part and Gölbaşı creek from the south-east parts, provides water to Lake Sünnet (Hoşgören and Ekinci 2004). However, water of level exhibits differences through the seasons. According to Abdüsselamoğlu (1959), lake level has been affected by water leaking from landslide set. Beside, level of water also affected by vaporizing of water based on atmosphere temperature and annual rainfall. While water level decrease until end of summer and autumn, it again starts to increase June and during the springs and riches maximum level in late winter time and spring. During the winter, lake surface water is completely covered by ice for 2-3 months. The lake is known its natural beauty and is surrounded by a rich flora and fauna.

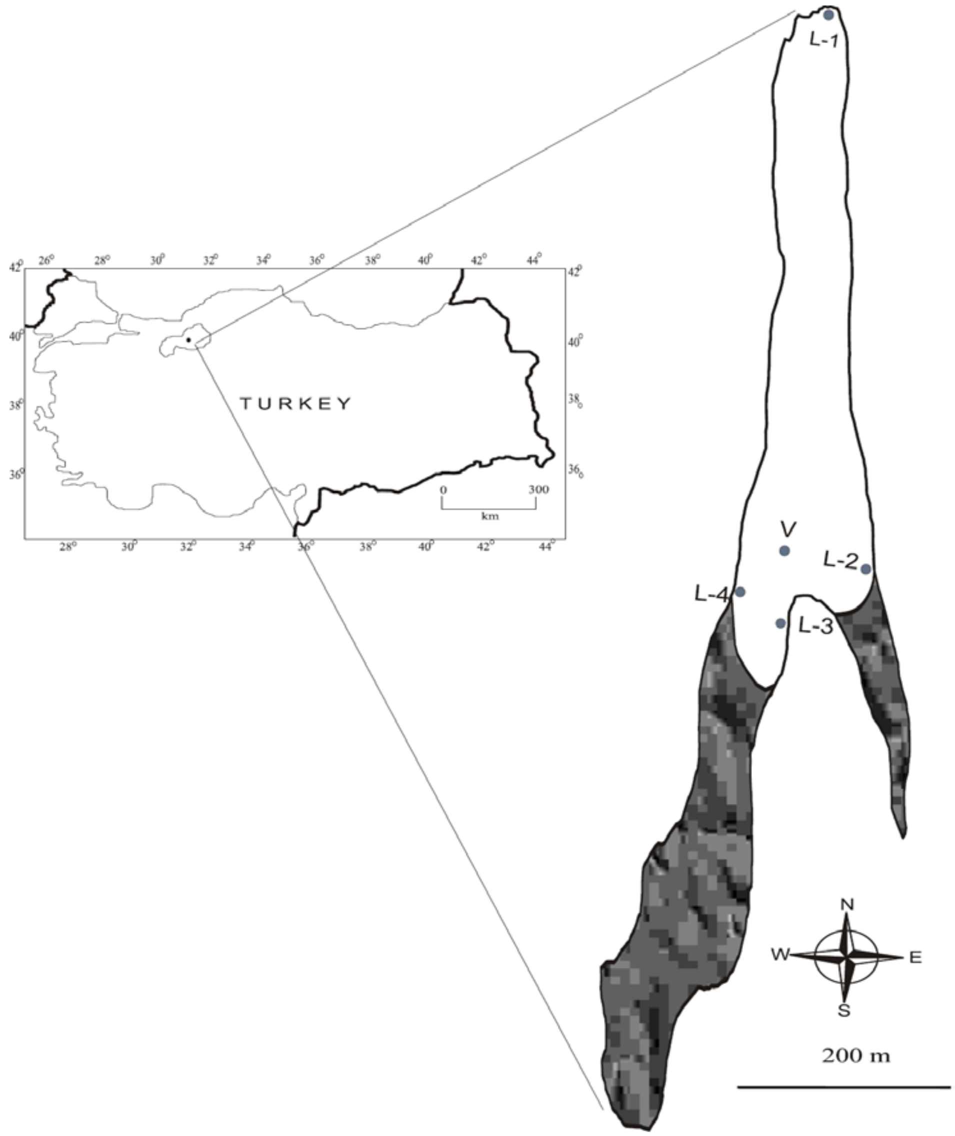

Figure 3 General appearance of Lake Sünnet with direction and sampling station. (Külköylüoğlu et al., 2007, Balcı, 2008)

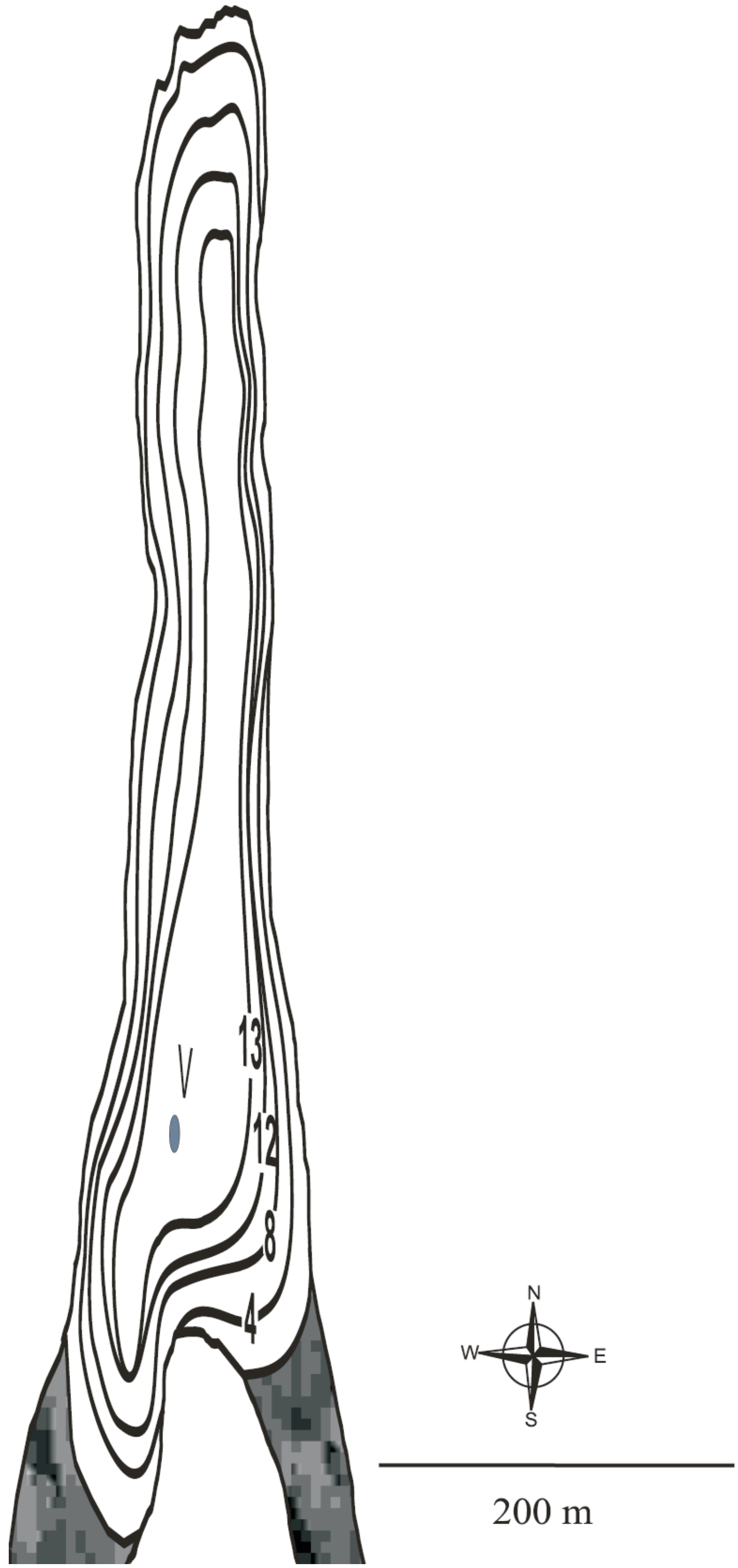

Figure 4 Batymetric graph of Lake Sünnet with depth lines (4, 8, 12, 13 m) (Balcı,2008)

2.2 Sampling Methods of Zooplankton

The zooplankton sampling was carried out monthly from 4 littoral and 2 vertical stations at the lake Sünnet between October 2005 and September 2007.Plankton net, which has 45 µm mesh size and 20 cm diameter were used. Vertical samplings were performed with zodiac boat to be used a 2.5- I Van Dorn bottle from surface area and 4 m depth of water. The geographical data, such as elevation, latitude and longitude, were obtained with a geographical positioning system (GARMIN, GPS 45 XL model)

2.3 Identification of Zooplankton

The samples for species identification was stored on 250 ml whirlpak typed sealed plastic bags and fixated to 4% formaldehyde. For permanent samples storage, 5 % glycerin gel was added to the bottle. Unfortunately, all permanent samples have been lost, while laboratory equipments were being moved.

Identification of zooplankton was made under a light microscope at 100X, 200X, and 400X magnifications. The shapes of zooplankton were photographed by the attachment of a BX 51 Olympus microscope camera. Several taxonomic Books were used to classification of zooplankton (Koste, 1978a, b; Simirvov, 1992; Nogrady et.al, 1995; Simirnov, 1996; Karaytug, 1999 ; Dussart and Defaye, 2001 ; Nogrady and Segers, 2002; Ueda and Reid, 2003; Wallace and Snell, 2006)

2.4 Physical, Chemical and Microbiological Analysis

Major environmental variables such as water temperature, dissolved oxygen (DO), percent oxygen saturation, air temperature, electrical conductivity (EC), salinity (PPT), pH, redox potential and total dissolved solid, were measured. Redox potential and pH were measured to use a Hanna model HI- 98150 pH/ ORP meter. All other variables were measured with YSI-85 model oxygen- temperature meter. (BOD_5) were calculated according to APHA method (1998). Atmospheric temperature and rainfall values were obtained for the study period from meteorology of Bolu.

Water samples were taken from selected sites about 250 ml for chemical analysis. Filtration method was used to determine the amount of particle in water. Additionally, turbidity (NTU) was measured in the hydrobiology laboratory with turbidity meter. After filtration, some chemical analyses were verified such as nitrate (NO_3) (DIN 38405-D9), nitrite (NO_2) (DIN 38405-D10), ammonium (NH_4) (DIN 38406-E5) and phosphate (PO_4) (DIN 38405 D 11) by spectrophotometric methods. (DR/50S). Chemical analyses were applied according to the DIN (Deutsches Institute für Normung) Standard method.

Microbiological analysis was made according to APHA method (1998). Firstly water samples were taken into the 100 ml whirlpak typed sealed plastic bags and inoculated on the EMB agar by using dilution method (Jay 1992). After that, these samples were incubated at 37 oC for 48 hours to count the colonies of bacteria. Characteristic colonies were counted on bacterial group concentrations based on a colony-forming unit per 1-milliliter basis (cfu/1ml). (Dufor, 1977).

2.5 Statistical Analyses

The relationship between the environmental variables and living zooplankton species were investigated by using canonical corresponding analysis (CCA) and monte carlo testing.

3 Results

3.1 Taxonomy of Rotifera

Phylum: Rotifera Cuvier, 1817

Class: Eurotatoria De Ridder, 1957

Subclass: Monogonanta Plate, 1889

Order: Ploimia Hundson and Gosse, 1886

Family: Brachionidae Ehrenberg, 1838

Genus: *Brachionus* Pallas, 1766

Brachionus angularis Gosse, 1851

Genus: *Keratella* Bory de St. Vincent, 1822

Keratella cochlearis Gosse, 1851

Keratella quadrata O. F. Müller, 1786

Genus: *Notholca* Gosse, 1886

Notholca acuminata Ehrenberg, 1832

Notholca squamula O. F. Müller, 1786

Genus: *Anuraeopsis* Lauterborn, 1900

Anuraeopsis fissa Gosse, 1851

Family: Euclanidae Ehrenberg, 1838

Genus: *Euclanis* Ehrenberg, 1832

Euclanis dilatata Ehrenberg, 1832

Family: Lapedellidae Harring, 1913

Genus: *Colurella* Bory de St Vincent, 1824

Colurella adriatica Ehrenberg, 1831

Family: Lecanidae Remane, 1933

Genus: *Lecane* Nitzsch, 1827

Lecane luna O. F. Muller, 1776

Lecane (M.) Closterocerco Schmarda, 1859

Lecane (M.) lunaris (Ehrenberg, 1832)

Family: Notommatidae Hundsonand Gosse, 1886

Genus*: Cephalodella* Bory de St Vincent, 1826

Cephalodella catellina O. F. Muller, 1786

Cephalodella gibba Ehrenberg, 1838

Family: Trichocercidae Harring, 1913

Genus: *Trichocerca* Lamarck, 1801

Trichocerca (D.) similis Wierzeski, 1893

Trichocerca (D.) weberi (sp) Jennings, 1903

Family: Gastropodidae Harring, 1913

Genus: *Ascomorpha* Perty, 1850

Ascomorpha ovalis Bergendahl, 1892

Family: Synchaetidae Hundson and Gosse, 1886

Genus: *Polrathra* Ehrenberg, 1834

Polyarthra dolichoptera Idelson, 1925

Polyarthra major Buckhardt, 1900

Polyarthra remata Skorikov, 1896

Family: Asplanchnidae Eckstein, 1883

Genus: *Asplanchna* Gosse, 1850

Asplanchna periodonta Gosse, 1850

Order: Flosculariacea Harring, 1913

Family: Testudinellidae Harring, 1913

Genus: *Pompholyx* Gosse, 1851

Pompholyx complanata Gosse, 1851

Family: Filinidae Harring and Myers, 1926

Genus: *Filinia* Bory de St. Vincent, 1824

Filinia longiseta Ehrenberg, 1834

Filinia terminalis Plate, 1886

3.2 Taxonomy of Cladocera

Phylum: Arthropoda Latreille, 1829

Class: Branchiopoda Latreille, 1817

Subclass: Phyllopoda Preuss, 1951

Order: Diplostraca Gerstaecker, 1866

Suborder: Cladocera Latreille, 1829

Family: Daphniidae Sars, 1865

Genus: *Daphnia* O. F. Müller, 1785

Daphnia longispina O. F. Müller, 1785

Family: Bosminidae Baird, 1845

Genus: *Bosmina* Baird, 1845

Bosmina longirostris O. F. Müller, 1785

Family: Chydorinae Stebbing, 1902

Genus*: Chydorus* Leach, 1816

Chydorus sphaericus O. F. Müller, 1776

1.1. Taxonomy of Copepoda

Phylum: Arthropoda Latreille, 1829

Class: Maxillopoda Dahl, 1956

Subclass: Copepoda, H. Milne- Edwards, 1840

Order: Cyclopoida Sars, 1918

Family:Cyclopoidae G.O. Sars, 1913

Genus: Cyclops O. F Müller, 1785

Genus: Thermocyclops Kiefer, 1927

3.3 Description and Ecology of Rotifer

Brachianus angularis (Gosse, 1851) Body has two small anteromedian spines; anterointermediate and anterolateral spines absent or highly reduced. Posterior spines are short or absent. Body length is 90 - 210 µm, body width is 60 - 160 µm.(Photo 4)

Ecology: It is a cosmopolitan and planktonic species. It is found almost all ponds, lakes, and ditch. Its tolerance range is known for pH between 4.8-9 and temperature between 0.5-28ºC. (Koste, 1978a)

Keratella cochlearis (Gosse, 1851)

Body is oblongata and narrow, spine usually1/4 of the total length. Anterior dorsal margin include six spines and it has a single posterior spine. And length of these spines can change based on climatically conditions. Body length is 80-200µm. (Photo 11)

Ecology: It is one of the most common planktonic and cosmopolitan rotifer which lives in freshwater, marine and brackish water. It is mostly found acidic waters. (Koste, 1978a)

Keratella quadrata (O. F. Müller, 1786)

It has six spines on anterior dorsal margin and two posterior spines. Length of posterior spines is usually equal length. Lorica is wider in the posterior than in the anterior portion. Body length is 150-250 µm. (Photo 12)

Ecology: It has wide temperature tolerance range. They are most common planktonic and cosmopolitan rotifers. It can be found almost all kind of water even if oligotrophic and eutrophic lakes. However, It can't live acidic and hypereutrophic conditions.

Notholca acuminate (Ehrenberg, 1832)

Shape of lorica may be ovoid, smooth or spindle. There are six spines in anterior. Both median spines are longer than the others. It has not foot. Body includes longitudinally lines through the lorica. Posterior part of the lorica is to be rounded. Body length is 200-360 µm, width; 90-120 µm, median spines; 20-42 µm. (Photo 16)

Ecology: It is polytypic, planktonic species. It is mostly found in cold water and freshwater. They are common in winter time.

Notholca squamula (O. F. Müller, 1786) (Photo 5. 17)

Body is usually ovoid. Anterior part of the lorica occur six spines. There is no foot. Posterior part has not any notch. Body length is 120-190 µm, width; 96-144 µm median spines; 18-34 µm. (Photo 17)

Ecology: It is a planktonic species and mostly found in freshwater lakes and canals. They are common in winter and spring time. It is also stenotermic species.

Anuraeopsis fissa (Gosse, 1851)

Lorica is finely stippled, more or less cylindrical and obtusely pointed posteriorly. Lorica made of two plates dorsal and ventral. The dorsal plate is round. Body length is 80-120 µm. (Photo 1)

Ecology: It is found ponds and lakes as a pelagic. They are stenothermic species and common in tropic and subtropics region.

Euclanis dilatata (Ehrenberg, 1832)

Lorica is thin and transparent. It includes both dorsal and ventral plaque. Anterodorsal margin has semicircular notch. They have two posterior toes like a s sword. Body length is 150-300 µm, width; 130-250 µm, toes; 50-100 µm. (Photo 8)

Ecology: It is a cosmopolitan species. They are found lakes and stream, especially littoral part of the lakes including plants.

Colurella adriatica (Ehrenberg, 1831)

Shape of lorica is considerably variable. Body length is 70-85 µm, toe; 25-40 µm. (Photo 7)

Ecology: It is a euryhaline and cosmopolitan species. Its tolerance range is known for pH between 5.5-10.5 and temperature between 5-30ºC.

Lecane luna (O. F. Muller, 1776)

Body shape may be ovoid or circular. Cuticula slightly become thick or thin. Foot has two segments but only last parts movable. Toes are long with claws. They have euclanis type corona and malleat type trophi. Body length is 150-250 µm in diameter. (Photo 14)

Ecology: It is usually found in littoral parts of the brackish and freshwater environment. Its tolerance range is known for pH between 6 -10.2, and it is common in littoral parts including 0.18-3.4 g/l chlorine.

Lecane (M.) Closterocerco (Schmarda, 1859)

Shape of body is ovoid or circular. It has both ventral and dorsal lorica. Dorsal lorica length is 54-85 dorsal width; 53-75 µm ventral lorica length is 57- 100 µm, ventral width; 44-92 µm; toe length; 21-42 µm. (Photo 13)

Ecology: It is mostly live in brackish, freshwater environment and stream. It is common in 5- 10 pH and 2.5-32 ºC temperature. They are also cosmopolitan species.

Lecane (M.) lunaris (Ehrenberg, 1832)

Body shape is ovoid and front part of lorica is concave. Dorsal lorica length is 90-115 µm, dorsal width; 75-100 µm, ventral length; 96-120 µm, ventral width; 55-89 µm, toe length; 42-76 µm, claws; 8-13 µm. (Photo 15)

Ecology: It is commonly found littoral parts of the lakes including plants. Its tolerance range is known 5-10 pH and5-26 ºC temperature. It is a cosmopolitan species.

Cephalodella catellina (O. F. Muller, 1786)

Body is short, stout and distally. It has short foot with overhanging tail and short straight, conical toes. Total length is 80-160 µm, toes; 9-14 µm. (Photo 5)

Ecology: It is a cosmopolitan species living in fresh to brackish water even if reported in marine waters. Its tolerance range is 12-24 ºC in temperature and 4.4-6.8 in pH. (Nogrady et. all, 1995)

Cephalodella gibba (Ehrenberg, 1838)

Body is slightly elongated. It has long, straight toes. Total length is 250-450 µm, toes; 67-150 µm, tophus; 70-90 µm. (Photo 6)

Ecology: It is a cosmopolitan species. They are common in acid and brackish water.

Trichocerca (D.) similis (Wierzejski, 1893)

Body is generally long and thin. It includes two teeth in anterior edge. Lorica and trophi is asymmetric. Toes are almost equal length to each other. Body length is 240-290 µm. (Photo 23)

Ecology: It is mostly found in macrophitic zone. Its tolerance range of pH is considerably wide and they are common in fresh water and high temperature.

Ascomorpha ovalis (Bergendahl, 1892)

Cuticular lorica is separated two plaques as ventral and dorsal. Corona occurs to ciliated structure. Its stomach includes 4 blind cases. Body length is 100-200 µm, trophi; 35 µm. (Photo 2)

Ecology: It is a cosmopolitan species usually living ponds and littoral parts of lake. It can be found some brackish water.

Polyarthra dolichoptera (Idelson, 1925)

Dorsal appendages are narrower than the ventral appendages. Body length is 80 - 140µm, appendages length; 110 -220 µm, appendages width; 7 -15 µm, ventral appendages; 60-72 µm. (Photo 18)

Ecology: It is a one of the common cosmopolitan species. Its tolerance range is known from temperature 4-10 ºC and 6-7 in pH.

Polyarthra major (Buckhardt, 1900) (Photos 5. 19)

Dorsal appendages are narrower than the ventral appendages. Body length is 80-140µm, appendages length; 120 -230 µm, appendages width; 8-17 µm, ventral appendages; 65-78 µm. (Photo 19)

Ecology: It is a one of the common cosmopolitan species. Its tolerance range is known from temperature 5-14 ºC and 6-7 in pH.

Polyarthra remata (Skorikov, 1896)

Dorsal appendages are longer than the body length. Posterior part of the body is circular including 3 lobes. Color of eye point may be deep red or black. Body length is 133- 180 µm. (Photo 20)

Ecology: It is cosmopolitan species that usually live in littoral part of the ponds and lakes as a pelagic species. They are common 5-10 in pH and 9-30 ºC in temperature.

Asplanchna periodonta (Gosse, 1850)

Body shape is ovoid or case shape. Vitellerium is circular including 8 -12 nuclei. Body length is 250-1500 µm in diameter. Trophi length is 60-80 µm. (Photo 3)

Ecology: It is cosmopolitan species that is generally found oligobeta saprobic water and also brackish water. It is known tolerance range from pH 4.5-8 and temperature 4-25 º C.

Pompholyx complanata (Gosse, 1851)

Body shape is ovoid. Posterior part of species becomes a circular node. It has two cerebral eyes. Eggs carry with posterior part of body. Body length is 70-150 µm and egg length is 60-70 µm. (Photo 21)

Ecology: It is generally found in ponds and lakes as a planktonic.

Filinia longiseta (Ehrenberg, 1834)

Body shape is ovoid or fusiform and without lorica. Lateral part is smooth including two long lateral appendages, and caudal part of body includes single long caudal appendage. Body length is 130 -250 µm, lateral appendages; 320 -370µm, caudal appendage; 125- 270 µm. (Photo 9)

Ecology: It is planktonic and cosmopolitan species that generally live in pond and lakes, especially hypolimnion and metalimnion layer of lakes. It is common in spring and autumn time.

Filinia terminalis (Plate, 1886)

Body shape is usually fusiform. It has two lateral appendages and a caudal appendage that is not thickened on connected point. Body length is 70 -195 µm, lateral appendage's length; 70-195 µm, caudal appendage's length; 230-370 µm. (Photo 10)

Ecology: It is cold stenotermic planktons and they are generally common in meta limnion and hypolimnion layer of lakes especially under 15 $^{\circ}$C in temperature.

3.4 Description and Ecology of Cladocera

Daphnia longispina (O. F. Müller, 1785)

Body is long and ovoid. It has a long shell spine behind the valves. Shell spine is thin and long. Rostrum is distinguished in female individuals. Postabdomen has 12-15 anal spin. Postabdominal claw does not include pectin. Body length is 2-2.5 mm in female and 1.5-2 mm in female individuals. (Photo 26)

Ecology: It is dominant species of the world's freshwater plankton. They are mostly common in Holarctic ponds and lakes.

Bosmina longirostris (O. F. Müller, 1785)

Body is generally egg shape or spherical. It has spine in the posterior parts of the carapax. First antenna is motionless and like as trunk. Postabdominal claw is with stout proximal pectin and very fine distal pectin. Sensory bristle is midway between eye and tip of rostrum. Body length is 0.4-0.6 mm in diameter. (Photo 24)

Ecology: It is normally found in the epilimnion and in lakes. It is common in temperate and tropical climates.

Chydorus sphaericus (O. F. Müller, 1776)

Body shape is spherical. Ventral part of carapax becomes a chitinous layer. Rostrum is s harp a nd l ong. A nd a lso f irst a ntenna i s s hort a nd t hick. P ostabdominal c law includes two basal spines. Structure of postabomen is short but wide. Body length is 0.4-0.6 mm in diameter. (Photo 25)

Ecology: It i s a com mon cladocera s pecies. They can live s horeline al most al l water system.

3.5 Evaluation of Data

Throughout the study, totaly twenty three rotifera and three cladocera at species level and t wo c opepoda a t genus l evel were r ecorded. Rotifera s pecies abundancy was dominant dur ing t he s tudy (Table 1). In t he phylum r otifera, *A. Periodonta, F. longiseta, F. terminalis, K. cochlearis, K. quadrata, P. doliceptera, P. remata, P. major* were almost found all sampling period. On the otherhand, the recorded rotifera species *C. gibba, E. dilatata, L. closterocerco, L. luna, L. lunaris, and T. milis* were interestingly recorded on May 2005 throughout the study. Besides, *B. Angularis, P. dolichoptera, P.remata, K. cochlearis, K. quadrata* were mostly observed on s pring period w hile *F. longiseta, F. terminalis* on a utumun. However, *P. dolichoptera, P.remata,* together with *F. longiseta, F. terminalis, K. cochlearis, K. quadrata* were common on w inter s eason. S pecies r ichness of phylum r otifera i ncreased on M ay 2006 but species density decreased at the same time. The rare species (*F. longiseta, F. terminalis, K. cochlearis, K. quadrata*) were r ecorded generally on spring a nd a lso winter season.

The recorded species belongs to cladocera such as *D. longispina, B. longirostris* were common during the study period. On the contrary, *C. sphaericus* was rare cladoceran species (Table 1). Moreover, t he r ecorded cladoceran s pecies abundancy de creased through the last period of summer. Additionally, *C. sphaericus* was detected only on May 2006.

The s pecies be long t o Copepoda w ere i dentified a t g enus l evel. In t his s tudy, copepoda genus w as only r epresented w ith t wo genus (Table 1). These g enus (*Thermocyclops* sp. and *Cyclops* sp.) were observed all study periods except summer.

Table 1 Zooplankton species recorded monthly

Rotifera	**October 2005**	**November 2005**	**March 2006**	**April 2006**	**May 2006**	**Jun 2006**	**July 2006**	**Augst 2006**	**September 2006**	**October 2006**	**November 2006**
Anuraeopsis fissa							*	*			
Ascomorpha ovalis					*		*	*			
Asplanchna periodonta	*	*	*	*		*	*		*	*	*
Brachionus angularis	*	*	*	*	*	*		*	*	*	*
Cephalodella catellina				*		*					
Cephalodella gibba					*						
Colurella adriatica			*	*			*				
Euclanis dilatata				*							
Filinia longiseta	*	*						*	*	*	*
Filinia terminalis	*	*				*		*	*	*	*
Keratella cochlearis	*	*	*	*		*		*	*	*	*
Keratella quadrata	*	*	*	*				*	*	*	*
Lecane (M.) Closterocerco					*						
Lecane (M.) lunaris					*						
Lecane luna					*						
Notholca acuminata					*					*	
Notholca squamula					*					*	
Polyarthra dolichoptera	*	*	*	*	*	*	*	*	*	*	*
Polyarthra major		*	*	*		*	*	*		*	*
Polyarthra remata	*	*	*	*			*	*			
Pompholyx complanata					*			*			
Trichocerca (D.) similis							*				
Trichocerca (D.) weberi (sp)		*					*				
Cladocera											
Daphnia longispina	*	*			*	*				*	*
Bosmina longirostris	*	*	*		*					*	*
Chydorus sphaericus					*						
Copepoda											
Thermocyclops sp.	*	*	*	*	*	*			*	*	*
Cyclops sp.		*	*		*	*			*	*	*

The reported physicochemical and biological data belongs to the lake and zooplankton community was collected monthly during 11 months. At the end of the study it was recorded that abiotic variables such as Dissolved oxygen, saturation, turbidity, Secchi depth decreased, while electrical conductivity, water temperature, percentage of dissolved solid materials increased with decreasing of water level at every season (Figure 5).

The studied area is used as a local touristic place and for some agricultural activities. Although, there are no negatively human effects on this area, it can be influenced from these factors.

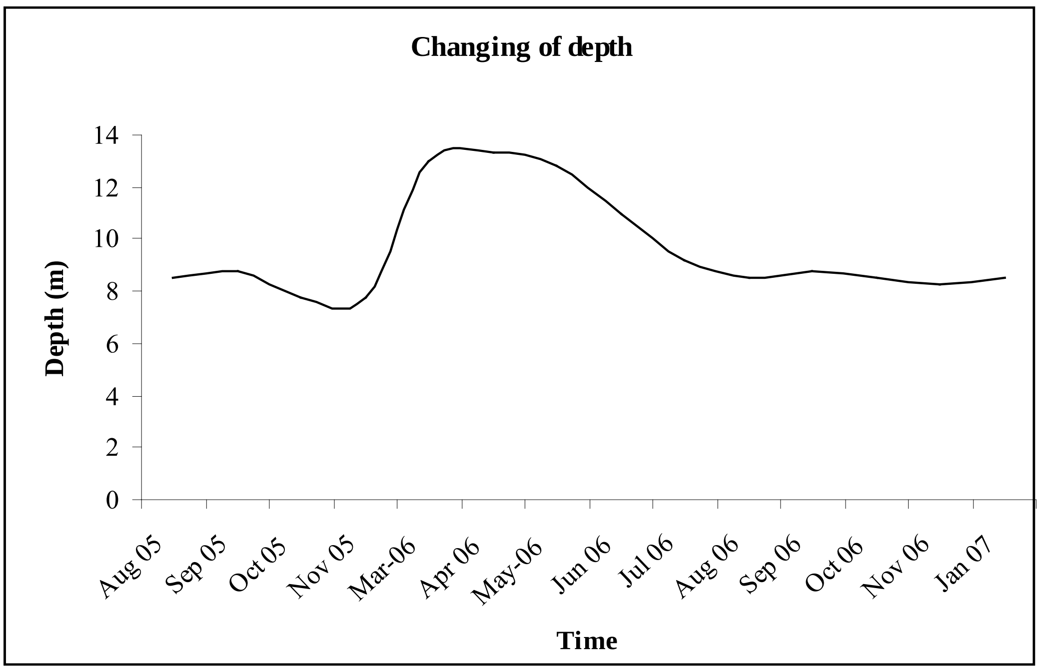

Figure 5 Monthly changing of the lake depth.

Among the recorded seasonal environmental variables there were results that are not significantly different from each other such as salinity and pH (Figure 5 and 6). Mean values of these variables was illustrated in Table 2. The measured salinity and pH values were recorded in small range during the study (Table 2).

In the later sampling period in April 2006 and June 2006 maximum and minimum BOD level measured 7.40 mg/L and 1.27 mg/L (Figure 4), respectively. While EC reached to maximum level in April 2006 and minimum level in September 2006 (Figure 7), the maximum turbidity value was recorded 6.33 in September 2006, and the minimum value was 2.39 in April 2006.

Table 2 The mean monthly physicochemical variables and secchi depth of the lake. The scientific abbreviations and unit of variables were determined as dissolve oxygen (DO, mg/l), water temperature (Tw, ^{o}C), saturation (Sat, %), SHE (mV), electrical conductivity (EC, µS/cm), total dissolved solids (TDS, mg/l), pH, Salinity (Sal, ppt), biological oxygen demand (BOD-mg/l) and Secchi depth (Sec, cm).

DATE	DO	T (w)	Sat	*SHE*	EC	TDS	pH	Sal	BOD	Secchi
Oct 05	9.35	10.37	84.85	216.51	415.36	278.29	7.95	0.21	5.86	120.00
Nov 05	6.69	5.95	53.87	219.38	411.85	275.94	8.05	0.20	3.07	95.00
Mar-06	4.05	7.59	34.77	218.31	471.96	316.21	8.21	0.29	2.03	150.00
Apr 06	2.84	11.06	26.46	216.06	502.04	336.37	7.98	0.24	1.27	110.00
May 06	2.75	14.14	28.52	214.06	473.76	317.42	7.85	0.24	1.34	140.00
Jun 06	7.01	15.71	83.76	213.04	453.09	303.57	7.78	0.24	7.40	210.00
Jul 06	6.68	17.94	73.09	211.59	438.28	293.65	7.81	0.24	4.01	115.00
Aug 06	6.65	17.31	72.88	212.00	415.45	278.35	7.77	0.22	4.70	80.00
Sep 06	6.57	14.54	66.88	213.80	403.44	270.30	7.72	0.22	5.09	80.00
Oct 06	6.48	11.44	60.82	179.47	418.19	280.18	7.61	0.22	6.64	80.00
Nov 06	7.48	6.46	62.09	178.40	418.19	280.19	7.72	0.20	2.69	80.00
Mean	6.05	12.05	58.91	208.42	438.33	293.68	7.86	0.23	4.01	114.55
Min	2.75	5.95	26.46	178.40	403.44	270.30	7.61	0.20	1.27	80.00
Max	9.35	17.94	84.85	219.38	502.04	336.37	8.21	0.29	7.40	210.00

Table 3 The mean monthly measured chemical variables, Turbidity, Coliform number, rainfall and air temperature (Ta) from vertical and littoral zones of the lake, rainfall and air temperature of Bolu (Turkey) region. The scientific unit of variables were determined as rainfall (kg/m^2), air temperature (Ta-^oC), Coliform bacteria as colony forming unit (cfu/ml), Turbidity (NTU), Nitrate (N-NO_3, mg/l), Nitrite (N-NO_2, mg/l), Ammoniac (N-NH_4, mg/l), Phosphate (P-PO_4, mg/l) and Sulphate (SO_4, mg/l).

Time	Rainfall	T (a)	Coliform	Turb	NH_4	NO_3	NO_2	PO_4	SO_4
Oct 05	52.1	10.3	323	4.94	0.07			0.01	0.003
Nov 05	63.7	6.6	275	6.15	0.32			0.01	
Mar-06	49.5	6.7	38	4.23	0.01	0.2	0.021	0.003	0.003
Apr 06	13.7	10.5	100	2.39	0.005	0.04	0.01	0.012	0.003
May-06	37	14	35	3.68	0.004	0.02	0.01	0.002	0.004
Jun 06	22.6	18.2	2330	2.61	0.006	0.02	0.003	0.002	0.003
Jul 06	12.6	19.4		3.83	0.005	0.002	0.003	0.001	0.004
Aug 06	1.8	23.2	150						
Sep 06	71.9	16	338	6.33	0.002	0.01	0.01	0.01	0.004
Oct 06	23.7	13	160	4.85	0.004	0.01	0.004	0.01	
Nov 06	37.5	5.6	3	5.17	0.03	0.01	0.01	0.012	
Mean	35.1	13.0455	375.2	4.418	0.0456	0.039	0.00888	0.0072	0.00343
Min	1.8	5.6	3	2.39	0.002	0.002	0.003	0.001	0.003
Max	71.9	23.2	2330	6.33	0.32	0.2	0.021	0.012	0.004

The mean values of the nitrate-nitrogen (N-NO_3), which were measured in the whole stations, changed between 0. 002 mg/L and 0.20 mg/L (Table 3). The highest value of N-NO_3 was measured as 0. 20 mg/l on March (Table 3 .) And Maximum Phosphate value was measured on April.

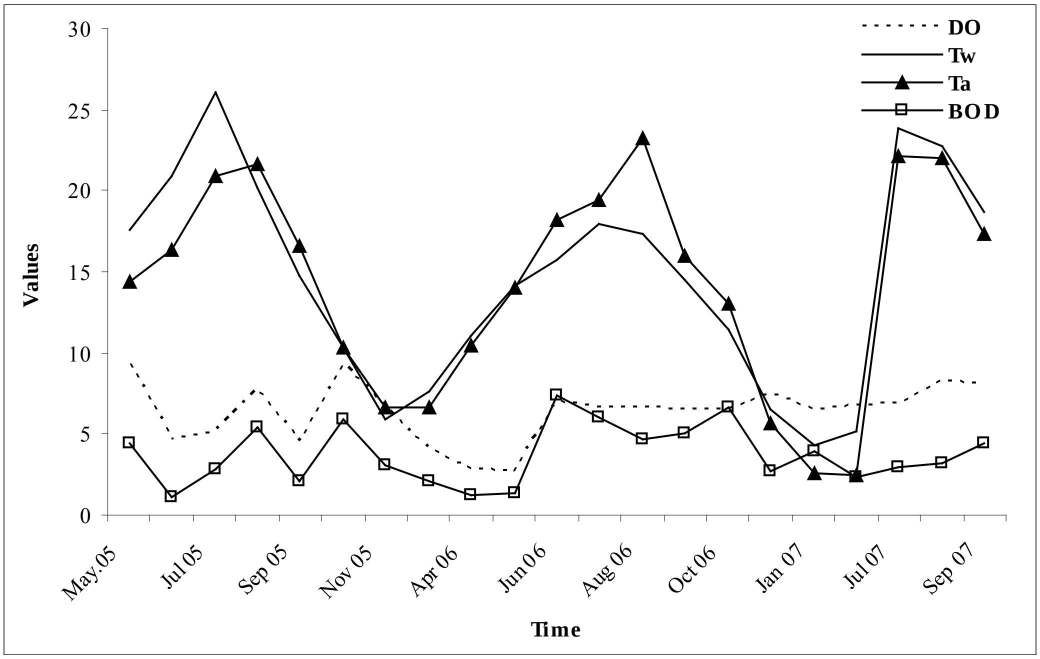

Figure 6 Seasonal changes of Dissolve Oxygen (DO), Temperature of water (Tw), Temperature of air (Ta), and Biological Oxygen Demand (BOD).

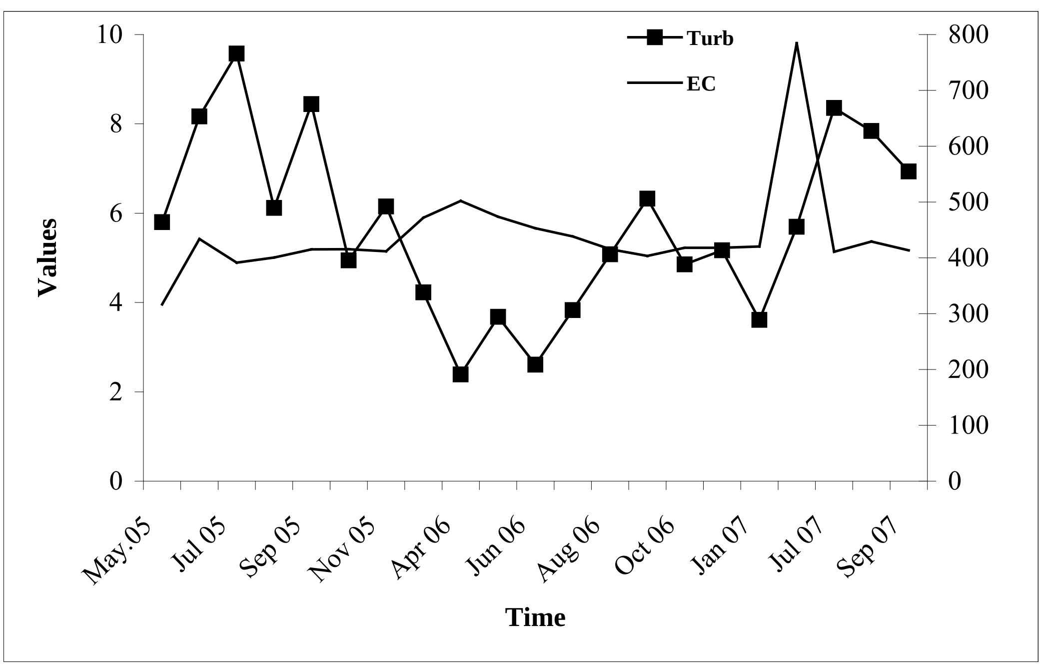

Figure 7 Seasonal changes of Electrical Conductivity (EC) and Turbidity.

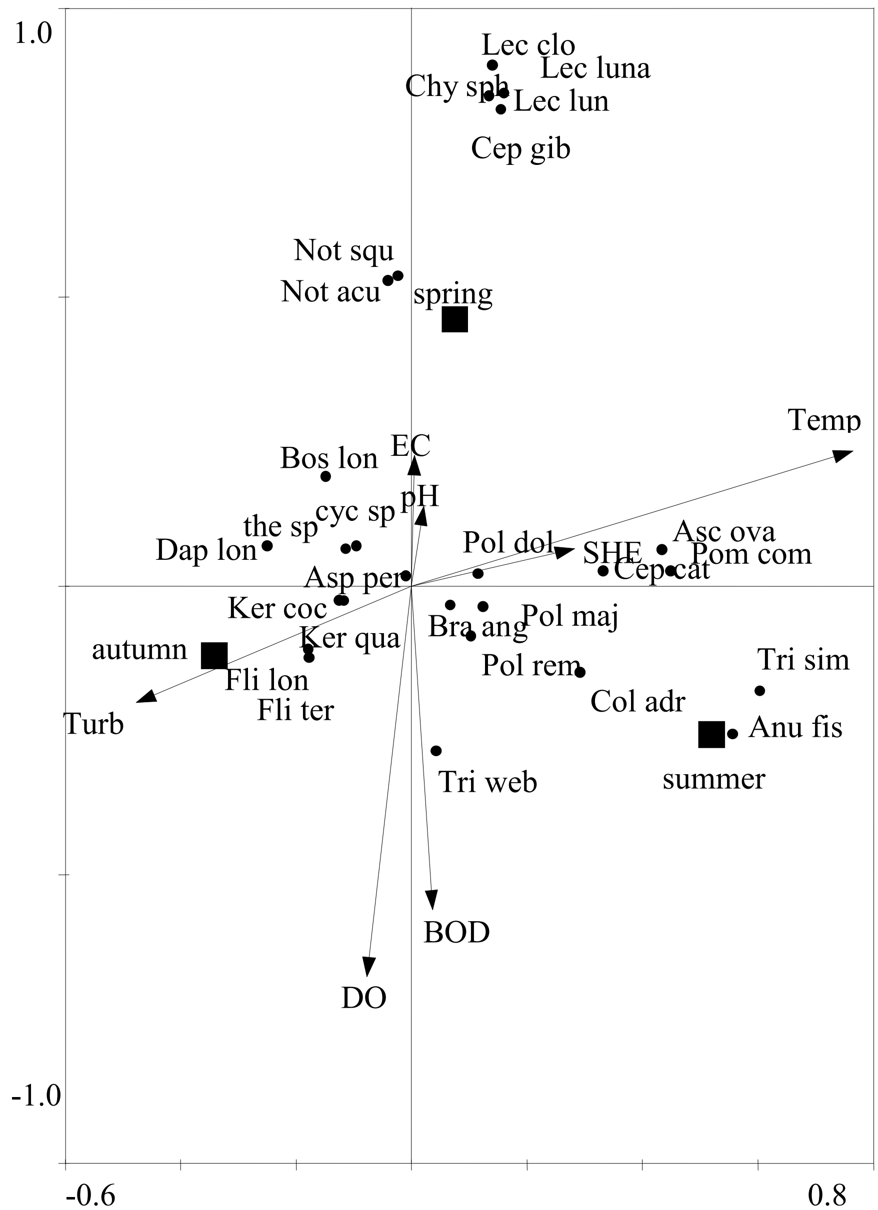

Figure 8 CCA diagrams for zooplankton and physicochemical parameters.

All variables transform to log (x+1) before tests due to skew distribution except pH. Temperatures, turbidity, DO and BOD has most important effect according to the results. On the contrary, % saturation and salinity were eliminated because of its less important value ($p<0.01$). Spring, autumn and summer used here as nominal variables. Rotifera species *N squamula, N. acuminate L. clostrocerca, L. luna, C. gibba* and *Chydorus sphericus* belongs to the cladocera have negative correlation with increasing DO and BOD and they generally found on spring time. *F. longiseta and F.terminalis* mostly found on autumn time and they have negative correlation with increasing temperature. *T. similis, T.weberii, C. Adriatica and A. fissa* have positive correlation with increasing temperature DO and BOD. They generally found on summer time.

Table 4 Summary of CCA and Monte Carlo test

**** Summary ****

Axes	1	2	3	4	Total inertia
Eigenvalues :	0.241	0.16	0.092	0.041	1.471
Species-environment correlations :	0.913	0.726	0.75	0.648	
Cumulative percentage variance					
of species data :	16.4	27.3	33.6	36.3	
of species-environment relation:	39.9	66.5	81.7	88.4	
Sum of all eigenvalues					1.471
Sum of all canonical eigenvalues					0.604

**** Summary of Monte Carlo test ****

Test of significance of first canonical axis: eigenvalue = 0.241

F-ratio = 10.795

P-value = 0.0020

Test of significance of all canonical axes : Trace = 0.604

F-ratio = 3.835

P-value = 0.0020

Tables show that selected variables explain 41% of total variance. Monte carlo tests for axes and all model indicate that important at the significant level ($p<0.005$).

4 Discussion and Conclusion

The mean measured physicochemical variables, secchi deep, chemical variables and number of coliform were given Table 2 and Table 3. Mean dissolved oxygen content changed based on deep changes and temperature. Low dissolved oxygen concentration during spring and summer were related to high temperature, oxygen depletion in bottom waters and also because of some agricultural activities. Besides number of coliform bacteria peak on June and that is the one important reason decreased of DO and pollution (Table 2). Zooplankton are highly affected these physicochemical, chemical and biological changes. Besides, rotifers are more quickly respond to environmental changes (Gannon and Stemberger, 1978).In this study zooplankton species were identified and results show that rotifera species were dominant among the zooplankton. Totally 28 zooplankton species were defined 23 species belongs to rotifera, 3 species to cladocera and two genus to copepoda (Table 1). Most of the identified zooplankton species were cosmopolitan species such as *A. periodonta, B. angularis, K. cochlearis, K. quadrata* and these cosmopolitan species were common almost every month. Although the lowest dissolved oxygen were recorded on may, species richness were differently very high in this month and rare species (*L. lunaris, L. luna, L. Closterocerco, C. gibba N. sqamula, N. acuminate and C. sphericus)* were observed on may. (Table 1) So, these results show that temperature is one of the important variables for plankton distribution. According to canonical correspondence analysis (CCA) results, there is positive correlation between pH and EC with cladocera and copepoda species (*B.longirostris, D.*

longispina, Thermocyclops sp., Cyclops sp. However, all these species and *L. lunaris, L. luna, L. Closterocerco, C. gibba N. sqamula, N. acuminate and C. sphericus* showed negative correlation with BOD and DO. Moreover, *F terminalis and F longiseta* showed negative correlation with temperature and they are generally common on autumn time. *Keratella cochlearis* and *K. quadrata, B. angularis, P. doliceptera, P remata* were dominant rotifer species during the study and their tolerance range is very high. So, these species were found both obtained minimum and maximum DO level (2.75 mg/L, 9.35 mg/L) (Table 2). Additionally, Gray (1953) announced that rotifera species can tolerate a high range of temperature variations. So, in Lake Sünnet, temperature ranges of cosmopolitan rotifer species were high as min 5.95ºC to max. 17.94ºC. Also Chemical variables are so important factors for zooplanktons distribution. Amount of nitrate and phosphate is a nutrient source of some plankton but in this study, according to canonical corresponding analysis CCA, there is no significant model between zooplankton and chemical variables.

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DIN 38405-9, Publication date: 1979-05 German standard methods for examination of water, wastewater and sludge; anions (group D), determination of nitrate ion (D9)

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http://www.cladocera.de/cladocera/cladocera.html

6 Appendices

6.1 Photos of Rotifera

Photo 1 ***Anuraeopsis fissa***

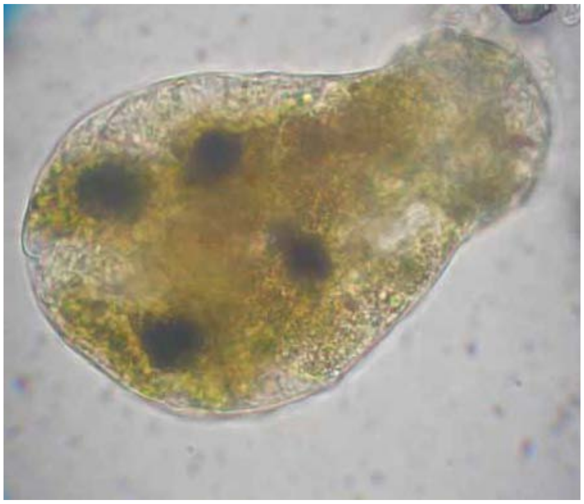

Photo 2 ***Ascomorpha ovalis***

Photo 3 ***Asplanchna. periodonta***

Photo 4 ***Brachionus angularis***

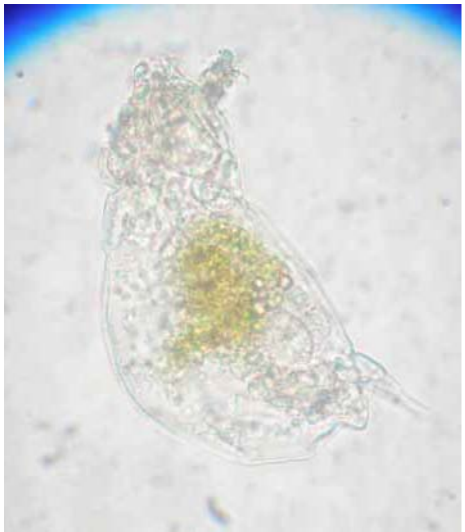

Photo 5 ***Cephalodella catellina***

Photo 6 ***Cephalodella gibba***

Photo 7 ***Colurella adriatica***

Photo 8 ***Euclanis dilatata***

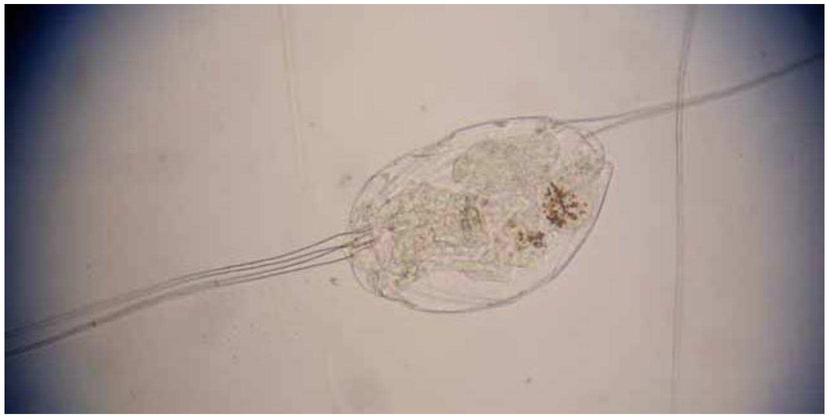

Photo 9 ***Filinia longiseta***

Photo 10 ***Filinia terminalis***

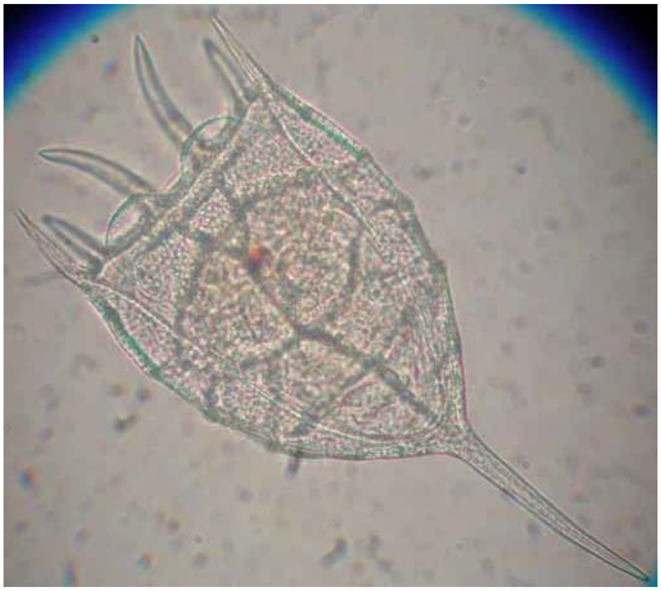

Photo 11 ***Keratella cochlearis***

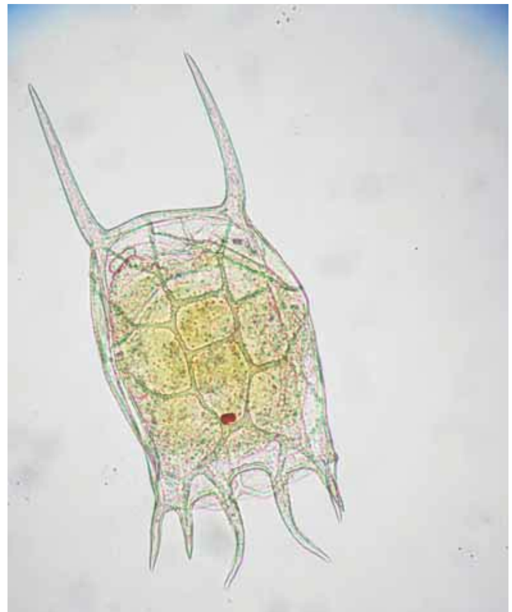

Photo 12 ***Keratella quadrata***

Photo 13 ***Lecane clastroceca***

Photo 14 ***Lecane luna***

Photo 15 ***Lecane lunaris***

Photo 16 ***Notholca acuminata***

Photo 17 ***Notholca squamulus***

Photo 18 ***Polyarthra doliceptera***

Photo 19 ***Polyarthra major***

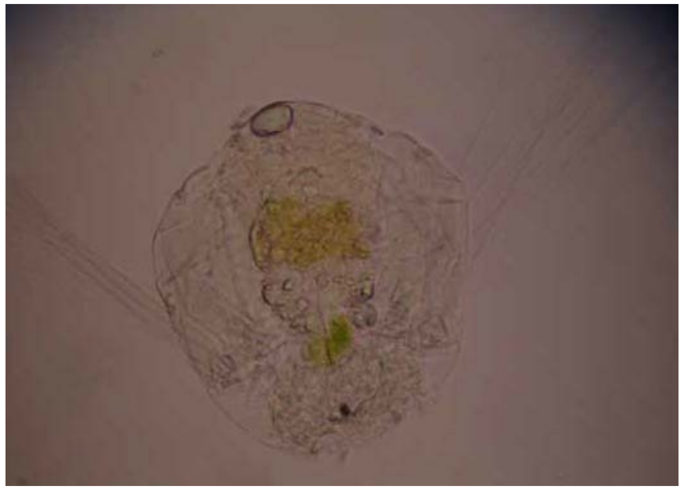

Photo 20 ***Polyarthra remata***

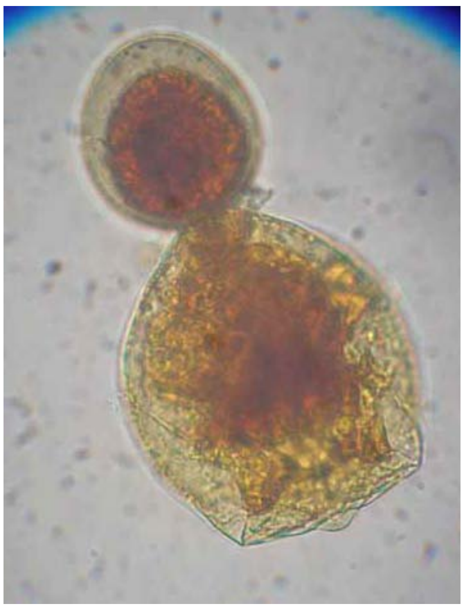

Photo 21 ***Pompholyx complanata***

Photo 22 ***Trichocerca weberii***

Photo 23 ***Trichocerca similis***

6.2 Photos of Cladocera

Photo 24 ***Bosmina longirostris***

Photo 25 ***Chydorus sphericus***

Photo 26 ***Daphnia longispina***

6.3 Photos of Copepoda

Photo 27 ***Thermocyclops sp***

Photo 28 ***Cyclops sp***

6.4 Photos of Stations

Photo 29 Station 1

Photo 30 Station 2

Photo 31 Station 3 and 4.

Photo 32 Water and sediment sampling.